

Resource Material in a Nutshell

by Hamsini Ravi

Section 1. Water and Health Linkages

Water is an important determinant of human health. Safe water, or the lack of, is as much a public health issue as it is a civic issue. Water can be an impediment to human health when there is a paucity of the resource, or if it is contaminated. Some common water borne diseases include malaria and diarrhea, which have high human mortality rates. Safe Water is listed as one of the Millennium Development Goals (MDGs), there is an urgent need across the world today, for policy makers, local governments and health care professionals to develop an integrated and sustainable solution to provision of safe and clean water.

1.1 Protecting and Promoting Human Health

While water-borne diseases cause a large percentage of death in developing countries, they can be prevented to a large extent by improving access to drinking water and sanitation and ensuring domestic and personal hygiene. However, there is very slow progress in this regard, particularly in traditionally poor areas of Sub-Saharan Africa and South Asia. Therefore, there is a need for an integrated approach to health and water. This comprehensive policy should be supplemented by organised planning, smooth implementation with maximum attention given to known vulnerable rural and urban areas, and will go a long way in saving millions of lives.

Reference: WHO (World Health Organization) and UNICEF (United Nations Children's Fund). 2006. 'Protecting and Promoting Human Health', in 'Water: A Shared Responsibility', The United Nations World Water Development, Report 2 by World Water Assessment Programme (WWAP). Paris: United Nations Educational Scientific and Cultural Organization and New York: Berghahn Books. Available online at <http://unesdoc.unesco.org/images/0014/001454/145405e.pdf#page=219> (accessed in June 2011)

1.2 Safer Water, Better Health: Costs, Benefits and Sustainability of Interventions to Protect and Promote Health

It is a known fact that ensuring cleaner water and better access to it can go a long way in improving public health. This also has extensive direct and indirect economic benefits. This document consolidates and presents recent findings on how global health is impacted by water resources, by outlining information of interventions, and summarising data from economic evaluations and describing financing insights. The health repercussions that are presented are derived from assessments and opinion reviews. While expert based opinions are not quite the same level of precision as intricate assessments, they provide interesting insights.

Reference: Prüss-Üstün, Annette, Robert Bos, Fiona Gore and Jamie Bartram. 2008. 'Safer Water, Better Health: Costs, Benefits and Sustainability of Interventions to Protect and Promote Health'. Geneva: World Health Organization. Available online at http://whqlibdoc.who.int/publications/2008/9789241596435_eng.pdf (accessed in June 2011).

1.3 Safe Water as the Key to Global Health

This report explores the challenges that the Millennium Development Goals pose in terms of access to safe water. It identifies the stumbling blocks to meeting the goals, what knowledge and tools need to be given to policy makers in the water and sanitation sphere, and explores options for provision of cheap and safe water to all. It also traces factors that hinder the provision of water access, viz. pitfalls in public policies and governance approaches, lack of finances, not maximising technology use etc.

Reference: Schuster-Wallace, Corinne J., Velma I. Grover, Zafar Adeel, Ulisses Confalonieri, Susan Elliott. 2008. 'Safe Water as the Key to Global Health', Report by the United Nations University. Hamilton: United Nations University International Network on Water, Environment and Health (UNU-INWEH). Available online at http://www.inweh.unu.edu/documents/SafeWater_Web_version.pdf (accessed in September 2011).

1.4 Ecosystems and Human Health- An Agenda for Research?

The paper is written on the premise that there is a missing link between the environment and human health, and recognises health as a pervasive index of social, physical, institutional and political factors. The paper examines

incidences of diseases, their distribution and inter-linkage with ecosystems. Along the way, it addresses the following themes: importance of transdisciplinary research investigation, recognition of uncertainty, analysis of socio-economic, institutional analysis, political economy of health, technological options for mitigating ecosystem related human health, impact and vulnerability analysis.

Reference: V. S. Saravanan and Peter P. Mollinga. 2011. 'The Environment and Human Health: An Agenda for Research', Background Paper for the ZEF Environment and Health Research Theme, Working Paper Series 82. Bonn: Centre for Development Research (ZEF), University of Bonn. Available online at http://www.zef.de/fileadmin/webfiles/downloads/zef_wp/wp82.pdf (accessed in September 2011).

1.5 The Water Poverty Index: An International Comparison

This paper breaks down the construction of an International Water Poverty Index, so that a locally based version of the water poverty index may be formulated. The Water Poverty Index attempts to express a measure linking household economic status with water access, underlining the relationship between water scarcity and human welfare. Such an index will make it possible to conduct socio-economic surveys of countries and communities and analysing it in connection with water scarcity. This would consolidate data on resources available and social factors that impact water, to enable national and international organisations to study and act on related issues easily. Hundred and forty countries are covered in the paper, and the detailed methodology is also given.

Reference: Lawrence, Peter, Jeremy Meigh and Caroline Sullivan. 2002. 'The Water Poverty Index: An International Comparison', Keele Economics Research Papers Series 19, pp. 1-19. Staffordshire: Keele University. Available online at <http://129.3.20.41/eps/dev/papers/0211/0211003.pdf> (accessed in June 2011).

1.6 Basic Epidemiology in Disease Surveillance

This is a training manual for state and district surveillance officers. Epidemiology and surveillance are keys for good public health, and therefore its basic concepts are important for the practitioners of public health. This is a basic manual that gives information on basic statistical methods.

Reference: WHO (World Health Organization) India. n.d. 'Disease Surveillance-Basic Epidemiology', Module 7. Training Manual for State & District Surveillance Officers. Integrated Disease Surveillance Project. New Delhi: WHO India. Available online at http://www.whoindia.org/LinkFiles/Public_Health_Laboratory_Networking_07.DSO-Module7.pdf (accessed in June 2011).

1.7 Behavior Change

The document is among the leaflets produced by the Environmental Health Project, primarily to document lessons learnt from the project so far. The project belongs to the USAID's Office of Health and Nutrition.

Reference: Favin, Michael and Diane Bendahmane. 1999. 'Behavior Change: Lessons Learned', Leaflet produced by the Environmental Health Project (EHP), United States Agency for International Development (USAID). Washington, D. C: USAID. Available online at http://www.ehproject.org/PDF/Lessons_Learned/behavior_change.pdf (accessed in June 2011).

1.8 Water Quality in South Asia

The paper presents an overview of water quality in the South Asian region. It touches upon the contamination of water with human faces. Water quality problems don't end with microbiological contamination, there is arsenic contamination, that can lead to cognitive impairment, cardiovascular diseases and cancer. Water can also be contaminated with industrial pollution. This melange of chemicals can pose a risk to human health.

Reference: Luby, Stephen. 2008. 'Water Quality in South Asia', *Journal of Health, Population and Nutrition*, Vol. 26, No. 2, pp. 123-124. Available online at <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2740663/> (accessed in September 2011).

1.9 Health and the Environment

The article talks of the relationship between human health and the environment. It touches upon air and water pollution

and the poisonous stuff they emit and the poisonous stuff they pose for human health. Adverse environmental conditions can cause cancer, respiratory, cardiovascular and even neurological diseases. There is also a special section in which children's health is examined briefly in relation to the environment. The article moves on to explain what needs to be done from the point of view of policies.

Reference: Luby, Stephen. 2008. 'Water Quality in South Asia', *Journal of Health, Population and Nutrition*, Vol. 26, No. 2, pp. 123-124. Available online at <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2740663/> (accessed in September 2011).

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Reference: OECD (Organisation for Economic Co-operation and Development). 2008. 'Health and the Environment', Policy Brief by OECD. Paris: OECD. Available online at <http://www.oecd.org/dataoecd/38/18/40396531.pdf> (accessed in September 2011)

1.10 Water Recreation and Disease: Plausibility of Associated Infections: Acute Effects, Sequelae and Mortality

The report talks of the heightened risk of being infected in the course of recreational activities involving water. Diseases arise out of exposure to pathogen in the water environment. As water based activities occur throughout the year, water users are in danger of being exposed to different pathogens in the water at different times. The report talks of evidence of diseases, and then go on to list out the plausible outcomes for different types of viruses and bacteria that may be encountered in water recreation.

Reference: Ponds, Kathy. 2005. 'Water Recreation and Disease: Plausibility of Associated Infections: Acute Effects, Sequelae and Mortality'. London: IWA Publishing. Available online at http://www.who.int/water_sanitation_health/bathing/recreadis.pdf (accessed in September 2011).

Section 2. Water Pollution and Health

Changing natures of economies, particularly in the developing world, cause a change in the state of its water resources, and therefore has an effect on the health of its citizens. Water resources are prone to pollution from industry, mining and agriculture, and face a growing threat thanks to twin increases in population and industrialisation. Water pollution can have adverse effects on human health, affecting all citizens irrespective of their socio-economic statuses. Diarrhoea, typhoid, cholera, are all caused by water pollution. Industries in the proximity of residential areas and even dumping of industrial effluents in the river will have a detrimental effect on the nearby population. Other sources of water, viz. groundwater, are by themselves not spared. The Arsenic contamination of groundwater in Bangladesh is only too well known. While alternative water sources are available to people who are economically strong, the low income groups have no choice but to depend on the contaminated water. In India, as well, high fluoride, arsenic and nitrate contamination of groundwater in rural and urban areas, cause substantial losses to the economy, in terms of the health costs it incurs to people.

2.1 Air and Water Pollution: Burden and Strategies for Control

The chapter focuses on effects on air and water pollution at the community, country and global levels. A detailed discourse on air pollution talks of the sources of outdoor air pollution, exposure to air pollutants and its impact on health. It also illustrates a short case study of arsenic pollution in Bangladesh. The section of water pollution also talks of its sources and its effects on public health. The section on interventions contains specialised case studies of reduction in air and water pollution from Mexico and India, respectively. It touches upon cost effectiveness and the economic benefits of implementing interventions. It concludes with a note on how research and development agenda should include strategies to combat air and water pollution.

Reference: Kjellstrom, Tord, Madhumita Lodh, Tony McMichael, Geetha Ranmuthugala, Rupendra Shrestha, and Sally Kingsland. 2006. 'Air and Water Pollution: Burden and Strategies for Control', in Dean T. Jamison, Joel G Breman,

Anthony R Measham, George Alleyne, Mariam Claeson, David B Evans, Prabhat Jha, Anne Mills, and Philip Musgrove. (eds), *Disease Control Priorities in Developing Countries*, pp.817-832. Washington, D.C.: World Bank. Available online at <http://www.ncbi.nlm.nih.gov/books/NBK11769/> (accessed in June 2011)

2.2 Impacts of Groundwater Contamination with Fluoride and Arsenic: Affliction Severity, Medical Cost and Wage Loss in Some Villages of India

High fluoride concentration in ground water in India is quite widespread, occurring especially in the states of Rajasthan, Gujarat, Tamil Nadu, Andhra Pradesh and Karnataka. Results of a field-based study that was held in six areas affected by fluorosis, proves that people who belong to the high income level can afford safe drinking water, and that low income groups feel the pinch of fluorosis affected water more. Medicinal cost and loss of pay forms a significant proportion of the earnings of the low income people and has a debilitating impact on the affected families. It is found that, over the entire affected population, fluoride and arsenic contamination pose high costs for society, and governmental agencies need to come up with a long term solution.

Reference: Indu, Rajnarayan, Sunderrajan Krishnan and Tushaar Shah. 2007. 'Impacts of Groundwater Contamination with Fluoride and Arsenic: Affliction severity, Medical Cost and Wage Loss in Some Villages of India', *International Journal of Rural Development*, Vol. 3, No. 1, pp. 63-93. Available online at irm.sagepub.com/content/3/1/69.full.pdf+html (accessed in August 2011)

2.3 Towards a More Effective Operational Response: Arsenic Contamination of Groundwater in South and East Asian Countries

Millions of people live near intensely contaminated groundwater that poses serious dangers to human health. Considerable research has been carried out to find the causes and effects of this contamination, and some operational responses have also been implemented. This paper documents the research and operational responses that have already been carried out. The paper reports a lack of cohesion with regards to the response to arsenic contamination, and calls for a more integrated and strategic approach in the future. Another major water contamination problem is the poor bacteriological water quality, which claims thousands of lives annually. As these problems occur at a humongous scale, trade-offs need to be consider, so take into account costs of mitigation measures. The paper suggests a cost-benefit analysis to help resolve this issue. The report specifies actions that can be taken at the national and global levels.

Reference: Kemper, Karin, Khawaja Minnatullah, Stephen Foster and Albert Tuinhof. 2005. 'Towards a More Effective Operational Response: Arsenic Contamination of Groundwater in South and East Asian Countries', Policy Report No 31303, Vol. I, pp. 1-63. New Delhi: Water and Sanitation Programme and Washington, D. C: The World Bank. Available online at http://siteresources.worldbank.org/INTSAREGTOPWATRES/Resources/ArsenicVolI_WholeReport.pdf (accessed in August 2011)

2.4 Managing the Arsenic Disaster in Water Supply: Risk Measurements, Cost of Illness and Policy Choices for Bangladesh

While, it is a well known fact that arsenic contamination in groundwater is a major public health threat in Bangladesh, facts, figures and analysis of its social and economic costs haven't been given too much thought. This paper, making use of primary data, examines health impact and costs associated with arsenic contamination in groundwater. It is estimated that up to 12 million working days per year are lost due to arsenic contamination. The total cost of illnesses due to arsenic exposure costs 557 to 997 million taka per year, and this cost is nearly 0.6 % of the annual income of affected individuals. In case of being able to provide arsenic-free alternate technologies to better health status, there is much social gain to be had. The study also finds that the threat of melanosis and Keratosis is differential for groups belonging to various economic strata.

Reference: Khan, M. Zakir Hossain. 2007. 'Managing the Arsenic Disaster in Water Supply: Risk Measurements, Cost of Illness and Policy Choices for Bangladesh', Working Paper No. 27-07 Kathmandu: South Asian Network for Development and Environmental Economics (SANDEE) Available online at <http://idl-bnc.idrc.ca/dspace/bitstream/10625/38905/1/128274.pdf> (accessed in June 2011)

2.5 Dietary Arsenic Exposure in Bangladesh

The paper describes an experiment in Pabna District in Bangladesh, where a group of researchers, strive to understand the relative contribution of food and drinking water to ingested Arsenic dose. While, it is a known fact, that millions of

Bangladeshi people are at risk of chronic arsenic toxicity from the contaminated groundwater, there is not much known about the diet which is an extra source of exposure to Arsenic. Female heads of the household were targeted, as they tend to be responsible for all food preparation. A duplicate diet survey was employed to quantify daily Arsenic intake in 47 women, and all samples were analysed for total Arsenic. A subset of 35 samples were measures for inorganic Arsenic. The conclusions of the experiment brought to light that drinking water concentrations exceeded the Bangladesh drinking water standard and that water was the main source of Arsenic exposure.

Reference: Kile, Molly L., E. Andres Houseman, Carrie V. Breton, Thomas Smith, Quazi Quamruzzaman, Mahmuder Rahman, Golam Mahiuddin, and David C. Christiani. 2007. 'Dietary Arsenic Exposure in Bangladesh', *Environmental Health Perspectives*, Vol. 115, No. 6, pp. 889–893. Available online at <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1892146/pdf/ehp0115-000889.pdf> (accessed in July 2011).

2.6 Recycled Water and Human Health Effects

The article explains some water recycling efforts for nondrinking use in urban Australia, and the effect it has on human health. The health threats of recycled water are those that relate to microbial waterborne disease. The paper also suggests two research approaches: Quantitative Microbial Risk Assessment (QMRA) and epidemiology that may be employed to assess health effects of recycled water. QMRA predicts the risk of human exposure to micro-organisms, while epidemiology provides information about characteristics and behaviour that reduces risk of a disease, so that interventions may be evaluated.

Reference: O'Toole, Joanne, Karin Leder and Martha Sinclair. 2007. 'Recycled Water and Human Health Effects', *Australian Family Physician*, Vol. 36, pp. 998-1000. Available online at <http://www.racgp.org.au/Content/NavigationMenu/Publications/AustralianFamilyPhys/2007issues/afp200712/200712o'toole.pdf> (accessed in September 2011).

2.7 Fluorosis Management Programme in India: The Impact of Networking Between Health and Rural Drinking Supply Implementing Agencies

The paper describes the fluorosis management programme in India. The programme works on (i) generating awareness, (ii) opting technology for fluoride removal (iii) advocating a calcium-rich and vitamin C and E and anti-oxidant-rich diet to negate fluoride effects. The programme is being administered by the Rural Development ministry. It touches upon aspects of fluorosis mitigation interventions and early fluorosis detection. It concludes with listing the major constraints in achieving fluorosis mitigation.

Reference: Susheela, A. K. 1999. 'Fluorosis Management Programme in India: The Impact of Networking Between Health and Rural Drinking Supply Implementing Agencies', *Current Science*, Vol. 77, No. 10, pp. 150-156. Available online at <http://www.fluorideandfluorosis.com/Reprints/pdf/Tox%20&%20Env%20Hlth.1999%20125-136.pdf> (accessed in September 2011).

2.8 Excess Fluoride Ingestion and Thyroid Hormone Derangements in Children Living in Delhi, India

This paper describes a study conducted among children living in fluoride endemic areas of Delhi. The sampling consisted of 90 female and male children showing symptoms of dental fluorosis. The results indicated that the children sampled were ingesting groundwater with high fluoride concentration.

Reference: Susheela, A. K., M. Bhatnagar, K. Vig and N. K. Mondal. 2005. 'Excess Fluoride Ingestion and Thyroid Hormone Derangements in Children Living in Delhi, India', *Fluoride*, Vol. 38, No. 2, pp. 151-161. Available online at http://poisonfluoride.com/pfpc/Susheela_Fluoride_2005.pdf (accessed in September 2011).

2.9 Water-related Diseases- Fluorosis

This fact sheet deals with fluorosis and how it affects people. It is commonly caused by excess fluoride in drinking water and can affect teeth and bones. The cause of the disease, its geographical distribution, the scope and seriousness of the problem and intervention are discussed in detail.

Reference: WHO (World Health Organization). n.d. 'Water-related Diseases- Fluorosis'. Geneva: WHO. Available online at http://www.who.int/water_sanitation_health/diseases/fluorosis/en/ (accessed in September 2011).

2.10 Groundwater Pollution and Contamination in India: The Emerging Challenge

Groundwater is an important source of drinking water in India. It fulfills 80% and 50% of rural and urban domestic needs respectively. However, a combination of land and water-based human activities care causing pollution to this finite source. It is contaminated by fluoride in almost all parts of India, and by arsenic in eastern parts of India. While listing the issues involved in tackling this contamination, it is found that water quality monitoring (WQM) is expensive as it involves sophisticated equipments. The technical limitations and problems with institutional design are also discussed. There is an entire section devoted to reducing the impact of polluted groundwater on human health. The Reverse Osmosis (RO) process to get rid of all impurities is suggested. The conclusion prescribes that policies must be focused on building capacities of agencies concerned with WQM, pollution management and that pollution control needs to be enforced effectively.

Reference: Kumar, Dinesh M and Tushaar Shah. 2006. 'Groundwater Pollution and Contamination in India: The Emerging Challenge'. IWMI (International Water Management Institute)-TATA Water Policy Program Draft Paper 2006/1. Vallabh Vidyanagar: IWMI-TATA Water Policy Research Program. Available online at http://www.iwmi.cgiar.org/iwmi-tata/files/pdf/ground-pollute4_FULL_.pdf (accessed in September 2011).

2.11 Strategies for Combating Nitrate Pollution

The paper is a comprehensive guide to nitrate pollution in India and strategies to combat the same. Nitrate can give rise to numerous health complications, viz, methemoglobinemia, oral cancer, cancer of the colon, rectum and other gastrointestinal cancers, Alzheimer's disease, vascular dementia, absorptive, secretive functional disorders of the intestinal mucosa, changes and so on. It then presents models to study nitrate leaching and other remedial measures and controls. Finally, the paper strives to present a snapshot of the current status of nitrate pollution in India.

Reference: Rao, E. V. S. Prakasa and K. Puttanna. 2006. 'Strategies for Combating Nitrate Pollution', *Current Science*, Vol. 91, No. 10, pp. 1335-1339. Available online at <http://www.iisc.ernet.in/currensci/nov252006/1335.pdf> (accessed in September 2011).

Section 3. Microbial Contamination of Water and Infectious Diseases

It is said that nearly four-fifth of the total diseases in developing countries are caused by water. Diarrhea is one of the major causes of child morbidity, and a definite link can be traced between diarrhea and improper sanitation.

Water tends to get polluted by microorganisms. While consumption of polluted water directly or indirectly can lead to water borne diseases, the improper disposal of excreted matter also contributes to water borne diseases causing waterborne diseases such as cholera, typhoid and Hepatitis. There is also another dimension of water borne diseases—the incidence of which is a result of inadequate water supply. Diseases like scabies, fungal infection and trachoma are examples of this phenomenon.

It is estimated that improper sanitation and unsafe drinking water have a higher mortality rate than war, terrorism and mass destruction weapons. (Berman: 2005)

References: Berman, Jessica. 2005. WHO: Waterborne Disease is World's Leading Killer. *Voice of America*. Available online at <http://www.voanews.com/english/news/a-13-2005-03-17-voa34-67381152.html> (accessed in September 2011).

3.1 CSE Draft Dossier: Health and Environment

This document discusses water pollution and the multiple ways in which it impacts human health. It examines the global nature of water-related infectious diseases, and then takes a closer look at their prevalence in India. There is a year-wise estimation of the number of diarrhoea cases, after which a state-by-state analysis is provided by which incidence of diarrhoea, drinking water and hospital infrastructure are compared and contrasted. The trend of cholera in independent India is also traced as is the relationship between sanitation and cholera. How disease control programmes impact vulnerable groups such as women, children and the poor are also illustrated. Transmission, sewage and waste disposal and urbanisation, and the impact that environment has on health is also given.

Reference: CSE (Center for Science and Environment). 1999. 'CSE Draft Dossier: Health and Environment'. New Delhi: CSE. Available online at <http://old.cseindia.org/programme/health/pdf/conf2006/a2indoorair.pdf> (accessed in June 2011).

3.2 Diarrheal Diseases

Diarrheal diseases cause child mortality, in developing countries. This chapter reviews existing interventions, throws light on transmission of the disease and the two types of diagnoses. The public health consequences of diarrhoeal diseases are along three lines: mortality, morbidity and long term consequences. The preventive strategies are described, analysed and their effectiveness assessed, and then analysed from the point of view of economics. The chapter concludes that existing interventions need to be scaled up if the UNDP is to attain its goal of reducing mortality rate by two-thirds by 2015. It also concludes that continued investment in diarrhoea research across basic, social and behavioural spectrums need to be made.

Reference: Keusch, Gerald T., Olivier Fontaine, Alok Bhargava, Cynthia BoschiPinto, Zulfiqar A. Bhutta, Eduardo Gotuzzo, Juan Rivera, Jeffrey Chow, Sonbol A. Shahid-Salles, and Ramanan Laxminarayan. 2006. 'Diarrheal Diseases', in Dean T. Jamison, Joel G. Breman, Anthony R. Measham, George Alleyne, Mariam Claeson, David B. Evans, Prabhat Jha, Anne Mills and Philip Musgrove, *Disease Control Priorities in Developing Countries*, pp.371-387. Washington DC: The World Bank. Available online at <http://files.dcp2.org/pdf/DCP/DCP19.pdf> (accessed in June 2011).

3.3 Exploring Intra-Household Factors for Diarrhoeal Diseases: A Study in Slums of Delhi, India

This paper is based on a study conducted in Delhi, to analyse risk factors, and examine whether they were located within a larger, socio-economic and political framework, as these factors were found to be separate variables. Most behavioural factors at the individual level are not found to be major determinants of the diarrhoeal diseases, when explored through a holistic epidemiology frame. A primary survey of 300 households was conducted and determinants at the household level were analysed. Storing of municipal water, considered among best storage practice did not prove to produce lower incidence of diarrhoeal diseases. Therefore it was found that major factors were external to the home, and beyond the immediate control of the household.

Reference: Dasgupta, Rajib. 2008. 'Exploring Intra-Household Factors for Diarrhoeal Diseases: A Study in Slums of Delhi, India', *Journal of Water and Health*, Vol. 6, No. 2, pp. 289-299. Available online at <http://www.iwaponline.com/jwh/006/0289/0060289.pdf> (accessed in June 2011)

3.4 Valuing Health Damages from Water Pollution in Urban Delhi, India: A Health Production Function Approach

Diarrhoea has reached endemic proportions in Delhi. One of the major causes of diarrhoea is low quality water. The paper traces a study conducted in low-income localities in Delhi on the health damages incurred in urban households by adopting an approach involving health production function. The probability of illness in the household was calculated from a model for valuing damages from contaminated water supplies. Some of the conclusions of the study is that improvement in water quality lowers incidences of waterborne diseases. Improvement in health also has a positive bearing on economic productivity. There are also traces of evidences to suggest that infrastructural variables such as garbage disposal and removal, water supply and sanitation play a key role in diarrhoea prevention.

Reference: Dasgupta, Purnamita. 2004. 'Valuing Health Damages from Water Pollution in Urban Delhi, India: A Health Production Function Approach', *Environment and Development Economics*, Vol. 9, No. 1, pp. 83-106. Available online at http://ideas.repec.org/a/cup/endeec/v9y2004i01p83-106_00.html (accessed in September 2011).

3.5 Impact of Malaria Control

This chapter assesses the impact of malaria control around the world, in different WHO regions, and even offers a country-by-country break down of the progress. The data primarily answers the following question: (a) Whether the progress is time-bound? (b) Whether there is any data on morbidity and mortality? (c) Whether any specific interventions have worked particularly well? The data consists of quantitative information about outpatients and inpatients, of medical tests and malaria mortality, all between 2001 and 2006.

Reference: WHO (World Health Organization). 2008. 'Impact of Malaria Control', in World Malaria Report 2008, pp. 27-32. WHO. Geneva: WHO. Available online at http://bepast.org/disease_information/malaria/malaria2008.pdf (accessed in June 2011).

3.6 Conquering Malaria

This comprehensive chapter on malaria, contains information on its causes, epidemiology, manifestations and diagnosis. Malaria is the eighth-highest contributor to the global disease burden, and the section dealing with the disease burden contains material on indirect and comorbid risks. Interventions that have been tried out so far are discussed along with their effectiveness. The Roll Back Malaria Campaign in 2005, has been chosen as a case study and explained. The economics of such interventions are also touched upon. The chapter concludes that existing strategies need to be employed more effectively, and deployed more widely. Existing tools need to be improved, and new tools need to be invented. Research and control activities need to be integrated.

Reference: Breman, Joel G., Anne Mills, Robert W. Snow, Jo-Ann Mulligan, Christian Lengeler, Kamini Mendis, Brian Sharp, Chantal Morel, Paola Marchesini, Nicholas J. White, Richard W. Steketee, and Ogobara K. Doumbo. 2006. 'Conquering Malaria', in Dean T. Jamison, Joel G. Bremen, Anthony R. Measham, George Alleyne, Mariam Claeson, David B. Evans, Prabhat Jha, Anne Mills and Philip Musgrove (eds), *Disease Control Priorities in Developing Countries*, pp.413-431. Washington, D.C.: World Bank. Available online at <http://files.dcp2.org/pdf/DCP/DCP21.pdf> (accessed in June 2011).

Section 4. Water Supply, Sanitation, Hygiene and Health

It is an established fact that public supply of water and public health are intrinsically linked to each other. Easy access to clean water can raise the public health standards of a certain area. In the developing water, water availability and sanitation patterns are different for urban and rural areas, which in turn has a huge bearing on the public health in these areas. This is especially in relevance to South Asia, where rural areas have different socio-economic dynamics from urban areas. Instead of policy attention given to rural areas, water and sanitation coverage is poor compared to urban areas. However, the urban poor are worst affected who do not have 'access' or 'affordability' for clean water supply and sanitation.

4.1 Water Supply, Sanitation and Hygiene Promotion

It has long been established that regular water supply has a positive effect on other development indicators such as health, nutrition levels etc. The paper goes into an in-depth discourse on water supply, sanitation and hygiene promotion in the following areas: levels of service and costs, policy implications and its direct health effects.

Reference: Cairncross, Sandy and Vivian Valdmanis. 2006. 'Water Supply, Sanitation and Hygiene Promototion', in Dean T. Jamison, Joel G. Bremen, Anthony R. Measham, George Alleyne, Mariam Claeson, David B. Evans, Prabhat Jha, Anne Mills and Philip Musgrove (eds), *Disease Control Priorities in Developing Countries*, pp. 771-792. Available online at <http://files.dcp2.org/pdf/DCP/DCP41.pdf> (accessed in June 2011).

4.2 Lessons Learned From Bangladesh, India and Pakistan: Scaling-Up Rural Sanitation in South Asia

This study includes a set of case studies from India, Bangladesh and Pakistan on sanitation in the rural pockets. The case studies are documentations of model projects and their innovative approaches to the age old issues of rural sanitation. The document also seeks to analyse the successes and failures, and how these can be integrated in upcoming projects. The case studies deal with behavioural change, health campaigns, sewerage schemes, low cost toilet installation etc. The projects range from small-scale NGO programmes that have covered 12 villages to large programmes that provided more than 1.5 million toilets in a single state.

Reference: WSP (Water and Sanitation Program). 2005. 'Lessons Learned from Bangladesh, India and Pakistan: Scaling –Up Rural Sanitation in South Asia', Report by the WSP. New Delhi: WSP. Available online at http://esa.un.org/iys/docs/san_lib_docs/Scaling%20Up%20Rural%20Sanitation.pdf (accessed in June 2011).

4.3 The Microbiology of Piped Distribution Systems and Public Health

This chapter deals with the microbiology of piped water distribution systems and its impact on public health. Though difficult to operate and maintain, piped systems are important sources of water, and enable us to provide treatment facilities in ensuring safe supply of drinking water. Drinking water distributing systems are breeding grounds for microorganisms, however these are not major threats to public health. While there are no long-term health effects from the survival of pathogens, there is potential for the organisms to accumulate and persist within biofilms. Microbial indicators such as E. Coli must be routinely monitored, and a holistic approach should be adopted in designing, operating and maintaining procedures.

Reference: Payment, Pierre and Will Robertson. 2004. 'The Microbiology of Piped Distribution Systems and Public Health', in Richard Ainsworth (ed), *Safe Piped Water: Managing Microbial Water Quality in Piped Distribution Systems*, pp. 1-18. London: IWA Publishing. Available online at http://www.who.int/water_sanitation_health/dwq/en/piped1.pdf (accessed in June 2011).

4.4 Learning from Experience- Water and Environmental Sanitation in India

This report traces the Water and environmental sanitation programme in India, that UNICEF has been involved with, for nearly three decades. The publication is meant to reach out to a wider audience, than just water experts, planners and researchers. This publication looks at four key areas that impact all water and sanitation programmes around the world and particularly in India, viz, coverage, technology, behavioural change and partnerships.

Reference: UNICEF (United Nations Children's Fund). 2002. 'Learning from Experience: Water and Environmental Sanitation in India'. A study by the UNICEF Evaluation Office. New York: UNICEF. Available online at http://www.unicef.org/publications/files/pub_wes_en.pdf (accessed in June 2011).

4.5 Water Supply and Sanitation (A WHO-UNICEF sponsored study)

This report assesses the condition of drinking water and sanitation in India and has been worked on by the Planning Commission, the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF). This report reviews priorities in national goals in drinking water and sanitation by analysing data and information to put together a report for assessment at the global level. It will also clarify any discrepancies in data and information and to provide information on national issues. The report also attempts to support reform and provide technical guidance to specific research and development and to draw more attention from investors to this sector.

Reference: Planning Commission, Government of India (GOI). 2002. 'India Assessment 2002-Water Supply and Sanitation (A WHO-UNICEF Sponsored Study)'. New Delhi: Planning Commission, GOI. Available online at <http://planningcommission.nic.in/reports/genrep/wtrsani.pdf> (accessed in June 2011).

4.6 Study on "Disease Burden due to Inadequate Water and Sanitation Facilities in India"

The paper describes a study conducted to assess disease burden as a result of inadequate water and sanitation facilities, as well as ill-awareness of hygiene issues. The study has been conducted in major cities in India, and the paper includes basic health issues due to improper water and sanitation, as well as an international perspective. Diseases have also been classified on the basis of transmission route and disease groups. How poverty and environment can affect and influence is also described. The report concludes by describing key problem areas and basic maladies and includes recommendations for a future course of action to strengthen collaboration, training, legislations and information systems.

Reference: Sulabh International Academy of Environmental Sanitation. n.d. 'Study on Disease Burden due to Inadequate Water and Sanitation Facilities in India', Final Report. Supported by the World Health Organization. Available online at http://www.whoindia.org/LinkFiles/Water_Quality_Disease_Burden_due_to_Inadequate_Water_&_Sanitation_Facilities_in_India.pdf (accessed in September 2011).

4.7 Household Water Treatment and Safe Storage Options in Developing Countries: A Review of Current Implementation Practices

To be in a position to provide safe water and sanitation facilities, we need to come up with better interventions that have the potential to be more sustainable. There is quite a debate around what constitute appropriate and effective interventions in developing countries. Communication campaigns can go a long way in straightening weak links between health and water. There is evidence to suggest that Household Water Treatment and Safe Storage (HWTS) can go a long way in prevention and cure of waterborne diseases. This paper examines HWTS and describes some common HWTS options, viz. chlorination, filtration (biosand and ceramic), solar disinfection, combined filtration/ chlorination and combined flocculation/ chlorination, describing implementation strategies of each. It also documents learnings, success stories and best practices.

Reference: Lantagne, Daniele S., Robert Quick and Eric D. Mintz. 2007. 'Household Water Treatment and Safe Storage Options in Developing Countries: A Review of Current Implementation Practices', in M. Parker, A. Williams and C. Youngblood (eds), *Water Stories: Expanding Opportunities in Small-Scale Water and Sanitation Projects*, pp. 17-38. Washington, D.C: Woodrow Wilson International Center for Scholars. Available online at <http://www.wilsoncenter.org/topics/pubs/WaterStoriesHousehold.pdf> (accessed in June 2011).

4.8 Social Returns from Drinking Water, Sanitation and Hygiene education: A Case Study of Two Coastal Villages in Kerala

This paper estimates social returns from investing in water, sanitation and hygiene education from the UNICEF model. The social investment is found to positively affect people in terms of poverty, health, longevity, education and environment quality. Taking up two factors; poverty and health, for valuation by case study method, the researcher uses two villages from Kerala. The study found that the averted annual public expenditure per household because of no waterborne and sanitation illness is Rs. 682. The costs for providing water and sanitation facilities is Rs. 12,086, therefore the ratio of benefit to cost is 3: 6. Therefore the study proves that there are numerous benefits from water supply, sanitation and hygiene education.

Reference: Pushpangadan, K. 2002. 'Social Returns from Drinking Water, Sanitation and Hygiene Education: A Case Study of Two Coastal Villages in Kerala'. Working Paper 333. Trivandrum: Centre for Development Studies (CDS). Available online at http://www.cds.edu/download_files/333.pdf (accessed in June 2011).

4.9 Wetlands & Water, Sanitation and Hygiene (WASH)- Understanding the Linkages

The publication presents issues linking wetlands and water, sanitation and hygiene. It also describes why these linkages are important and how they can be better managed. It focusses on rural and peri-urban areas in developing countries. The publication also dwells into associated risks and benefits of the linkages between wetlands and water, sanitation and hygiene.

Reference: Wetlands International. 2010. Wetlands & Water, Sanitation and Hygiene (WASH)- Understanding the Linkages. Ede: Wetlands International. Available online at http://www.pnuma.org/agua-miaac/SUBREGIONAL%20MESO/MATERIAL%20ADICIONAL/BIBLIOGRAFIA-WEBGRAFIA/Modulo%201%20MIAAC%20en%20el%20contexto%20de%20gestion%20para%20DS/Gestion%20Integrada%20de%20RH/Doc%205.%20WI_WASH-lowres+with+bookmarks.pdf (Accessed in September 2011).

Section 5. Disasters, Water and Health

Disasters are a recent addition to the study of natural resources management. One of the consequences of climate change has been the increase in the incidence of natural disasters. Disasters result in death, displacement, loss of livelihood, widespread destructions, but also have alarming and far reaching effects on human health. Disasters may result in different types of injury, communicable diseases (that have a greater chance of spreading, because of abnormal living conditions), acute illnesses, chronic illnesses and psychological effects.

5.1 Communicable Diseases Following Natural Disasters: Risk Assessment and Priority Interventions

The document describes communicable disease risks among population afflicted by natural disasters. It describes priority measures to prevent and reduce disease impact in the post disaster time zone. The prevention is classified under the following headings: safe water, sanitation and site planning; Primary health-care services, Surveillance/early warning system, immunization and prevention of malaria and dengue.

Reference: WHO (World Health Organization). 2006. 'Communicable Diseases Following Natural Disasters: Risk Assessment and Priority Interventions', Document developed by the Communicable Diseases Working Group on Emergencies (CD-WGE). Geneva: WHO. Available online at http://www.who.int/diseasecontrol_emergencies/guidelines/CD_Disasters_26_06.pdf (accessed in September 2011).

5.2 Disaster Management in India: Status Report

This report describes the status of disaster management in India, tracing its journeys on how it combated past disasters, and lays a roadmap for how it plans to deal with future emergency situations. It has sections on its institutional and policy framework and how it will prevent or mitigate disasters, and finally, how it will manage a disaster, if it has happened.

Reference: National Disaster Management Division, Government of India (GOI). 2004. 'Disaster Management in India: A Status Report'. New Delhi: National Disaster Management Division, GOI. Available online at <http://www.ndmindia.nic.in/EQProjects/Disaster%20Management%20in%20India%20-%20A%20Status%20Report%20-%20August%202004.pdf> (accessed in June 2011).

5.3 Disaster Response Preparedness Plan: Part I

The UN agencies in Nepal is committed to respond proactively to disasters, mitigating them wherever possible and take proper steps for rehabilitation and care. The document provides guidelines for future emergency preparations, to other development agencies. The document covers the following aspects: staff safety, programme readiness, operations readiness, collaborative arrangements and capacity building.

Reference: United Nations Disaster Management Team. 2001. 'Disaster Response Preparedness Plan: Part I', Plan Document prepared by the United Nations Nepal's Inter-Agency. Kathmandu: United Disaster Management Team. Available online at http://www.undp.org/cpr/disred/documents/regions/asia/nepal_prepI.pdf (accessed in June 2011)

5.4 Towards a Safer Sri Lanka: A Road Map for Disaster Risk Management

This document highlights the vision for paving the way to handle and prevent disasters effectively. It has short, medium as well as long term plans of action in place. It also indicates its qualitative and quantitative needs in terms of human resources, funds and equipment, in order to achieve this vision. The strategies proposed are structured along the following themes: Policy, Institutional Mandates and Institutional Development; Hazard, Vulnerability & Risk Assessment, Multi-hazard Early Warning Systems; Disaster Preparedness Planning and Response; Disaster Mitigation and Integration into Development Planning; Community based Disaster Management; and Training, Education and Public Awareness.

Reference: Disaster Management Centre, Government of Sri Lanka. 2005. 'Towards a Safer Sri Lanka: A Road Map for Disaster Risk Management'. Colombo: Disaster Management Centre, Government of Sri Lanka. Available online at http://www.preventionweb.net/files/17954_gosroadmapdismanagcentre.pdf (accessed in June 2011)

Section 6. Water Resource Management and Health

Increasing rates urbanisation, deforestation and dam construction cause ecological changes leading to increase in vector density, and in turn transmission of vector-borne diseases. Current studies indicate that close to 15.3 million people live near large dams and about 845 million near irrigation projects (Keiser et al 2005). This calls for better management of not just dam construction, but also waste water, and sustained and concentrated interventions, in areas where dams are built, to prevent and treat vector-borne diseases. Dams are not the only water bodies affecting health, groundwater can be a potentially dangerous source of health hazards, and also contaminates agricultural crops. The arsenic contamination of groundwater in Bangladesh, is a case in point, causing diseases such as melanosis, leucolalanosis, keratosis and even skin cancer. (Safiuddin and Karim, 2003). Waste water, particularly, partially treated or untreated wastewater, poses a number of health risks. Health hazards could be directly related to rural health or a safety problem for those who live in close proximity to water. Waste water carries a plethora of bacteria, viruses, protozoa and helminths, which in turn cause a number of health complications.

Reference: Keiser, Jennifer, Marcia Caldas De Castro, Michael F. Maltese, Robert Bos, Marcel Tanner, Burton H. Singer and Jurg Utzinger. 2005. 'Effect of Irrigation and Large Dams on the Burden of Malaria on a Global and Regional Scale', *The American Journal of Tropical Medicine and Hygiene*, Vol. 72, No.4, pp. 392-406. Available online at <http://www.ajtmh.org/content/72/4/392.long> (accessed in June 2011).

Safiuddin, Mohammed and Mohammed Masud Karim. 2003. 'Water Resources Management in the Remediation of Groundwater Arsenic Contamination in Bangladesh', in T. Murphy and J. Guo (eds), *Aquatic Arsenic Toxicity and Treatment*. Available online at <http://www.eng-consult.com/pub/Arsenicbook.pdf> (accessed in June 2011).

6.1 Human Health in Water Resources Development

Some developments of water resources, such as building dams and irrigation systems, can have adverse effects on human health. This usually happens through the spread of waterborne disease like malaria and schistosomiasis. Therefore before undertaking water development projects, it is necessary to integrate health impact studies in it. Examples of this can include the alternate wet dry method of rice cultivation and improved drainage in canal irrigation

system. Treatment of waste water is another issue that is talked about in the paper, they can be effectively used in peri-urban agriculture. This is an effective way to treat waste water, in the absence of costly waste treatments. Thus, it is important to understand that water development projects can cause environmental and social changes and that government should work out sustainable solutions to deal with these.

Reference: Hoek, Wim van der. n.d. 'Human Health in Water Resources Development'. Water and Health. Encyclopedia of Life Support Systems. Available online at <http://www.eolss.net/ebooks/Sample%20Chapters/C03/E2-20A-05.pdf> (accessed in June 2011).

6.2 Water Quality in Developing Countries, South Asia, South Africa, Water Quality Management and Activities that Cause Water Pollution

The paper examines water quality in developing countries in the South Asian and African regions. The water quality is variable and reflects the geography's socio-economic conditions. It also examines management of water quality that can combat any type of pollution and water body. The paper, further, dwells into activities that cause deterioration of water quality. There is a prescription of what a national water policy should include, viz, a framework that gives strategic and political directions for future management and an action plan that shows an understanding of social and economic costs. There is a section on Environmental health risks that explains how risk factors are assessed.

Reference: Abbaspour, Sonaya. 2011. 'Water Quality in Developing Countries, South Asia, South Africa, Water Quality Management and Activities that Cause Water Pollution', International Proceedings of Chemical, Biological and Environmental Engineering, Vol. 15, pp.94-102. Available online at <http://www.ipcbee.com/vol15/17-U10016.pdf> (accessed in September 2011).

6.3 Water Resources Management in the Remediation of Groundwater Arsenic Contamination in Bangladesh

Bangladesh is one of the worst sufferers of arsenic contamination in the world, and shallow tube wells for drinking water are not an option anymore. Arsenic contamination is so severe that alternate replacements for groundwater are being looked for. Options like ponds, lakes, canals and rivers are being explored. To combat an arsenic disaster effectively, a community needs to have access to affordable and sustainable water sources. It also tends careful and integrated water resources management to ensure supply of drinking water. Water resources needs to be managed by a community in rural Bangladesh. This paper presents a simple water resources management model that is primarily community-based. The research in the paper presents the proposition that water resources management needs hands-on participation from the local community.

Reference: Safiuddin, Mohammed and Mohammed Masud Karim. 2003. 'Water Resources Management in the Remediation of Groundwater Arsenic Contamination in Bangladesh', in T. Murphy and J. Guo (eds), *Aquatic Arsenic Toxicity and Treatment*, pp.1-17. Available online at <http://www.eng-consult.com/pub/Arsenicbook.pdf> (accessed in June 2011).

6.4 Effect of Irrigation and Large Dams on the Burden of Malaria on a Global and Regional Scale

Water resource development projects have been implemented at a stunning pace over the past few decades. According to estimates, 40,000 large dams and 800,000 small dams have been built over the past fifty years. Traditionally, the establishment and management of these water projects have caused an unprecedented in malarial and other vector diseases. This report assesses the impact of dams and irrigation on malaria (both incidence and prevalence). The statistics are specified according to incidences in each of the World Health Organization (WHO)'s sub-regions. The level of risk of a popular depends on its proximity to irrigation projects and large dams. In the sub-regions that are classified as dangerous, close to 15.3 million people live near large dams and 845 million near irrigation projects. The risk that a water project may trigger malarial transmission depends of other factors, viz. epidemiologic setting, socio-economics, vector management and health conditions. The paper concludes that wholesome malarial control measures, along with proper water management can mitigate spread of malaria near irrigation projects and dams.

Reference: Keiser, Jennifer, Marcia Caldas De Castro, Michael F. Maltese, Robert Bos, Marcel Tanner, Burton H. Singer and Jurg Utzinger. 2005. 'Effect of Irrigation and Large Dams on the Burden of Malaria on a Global and Regional Scale', *The American Journal of Tropical Medicine and Hygiene*, Vol. 72, No.4, pp. 392-406. Available online at <http://www.ajtmh.org/content/72/4/392.long> (accessed in June 2011).

6.5 Guidelines for the Incorporation of Health Safeguards into Irrigation Projects through Intersectoral Cooperation (With Special Reference to the Vector-Borne Diseases)

This document is written for policy makers who are managing irrigation projects, and would like to get themselves acquainted with the effect of such projects on public health. The introduction is a briefing on vector-borne diseases and how it is associated with irrigation development, and the circumstances in which irrigation projects can pose health risks. After the introduction, the publication, suggest the number of ways in which public health managers and irrigation specialists can work together on intersectoral projects, and gives detailed scenarios, breaking it down for projects depending on its size and specific requirements.

Reference: Tiffen, Mary. 1991. 'Guidelines for the Incorporation of Health Safeguards into Irrigation Projects through Intersectoral Cooperation (With Special Reference to the Vector-Borne diseases)', Guidelines Series. Geneva: World Health Organization. Available online at <http://gc21.inwent.org/ibt/en/modules/gc21/ws-nrm-net/ibt/downloads/dialogue/peem.pdf> (accessed in June 2011)

Section 7. Water, Health and Equity

The relationship between water and health is a starting point to the huge role played by rights and equity, in sectoral policy debates. Rights perspectives are being integrated into both assessments of existing projects, as well as a policy and programming response. Cross-sectoral working in this sphere is necessary for realising rights.

One of the advantages of working on a rights based approach is that, policy makers are forced to consider solutions outside the technical framework, and look at economic, social and political factors.

The right to life and survival is a basic human right, therefore one can draw a parallel between human rights and equitable health, and access to health services. As far as health care is concerned, there are proved benefits of following a rights-based approach. A real rights-based approach will focus on accessibility of services, accountability of service providers to rights holders and political, social and institutional factors affecting health.

7.1 Basic Needs and the Right to Health

This chapter studies the intricate nature of the water cycle, in the context of the global water crisis. It explores the multiple ways in which we use water, and the pressure that the resource is under. With over 86% of diseases in the development world directly or indirectly caused by water, ill-health as a result of improper access to water and sanitation is a major section in the publication. Supply of water and sanitation are also studied in the context of specific regions, viz, Africa, Latin America, Asia and the Caribbean. Water as a human right is a major contention in development circles today, as issues of decentralization, privatization crop up. These issues are discussed in the backdrop of public health.

Reference: World Health Organization (WHO) Collaborating agency: United Nations Children's Fund (UNICEF). 2003. 'Basic Needs and the Right to Health', in 'Water for People, Water for Life: The 1st UN World Water Development Report'. pp. 97-125. Paris: UNESCO and New York: Berghahn Books. Available online at <http://unesdoc.unesco.org/images/0012/001297/129726e.pdf#page=123> (accessed in June 2011)

7.2 Implementing Equity: The Commission on Social Determinants of Health

A report of the Commission on Social Determinants of Health (CSDH) states that civil society groups from around the world are important players in the crusade for global health equity. Civil society can also be an effective complementary force, to governmental action. Their key contributions from civil society is in identifying structural drivers of health equity, and developing, implementing and evaluating existing health systems. The CSDH report also recognises the all-important role that WHO plays, and is sceptical about influential philanthropists, who while making generous contributions to the global health budget, tend to influence international health policy.

Reference: Birch, Marion. 2009. 'Implementing Equity: the Commission on Social Determinants of Health', *The Bulletin of the World Health Organization*, Vol. 87, No.3. Available online at <http://www.who.int/bulletin/volumes/87/1/08-061978.pdf> (accessed in June 2011)

7.3 Malaria and Right to Health

The paper studies the right based approach to health and in the context of malaria in particular. Malaria is described as a neglected disease that is very strongly linked to poverty. Neglected diseases have some typical characteristics, such as affecting poor communities, and can be combated effectively by basic public health measures, such as access to sanitation, water; and new diagnostics, drugs and vaccines have been under-funded or neglected. A rights-based approach to malaria, particularly, includes a comprehensive set of rights, such as the right to an integrated health care system, opportunity to access anti-malarial treatment, prevention methods and care, if necessary, access to adequate housing and water and sanitation, and even a commitment to research and development of treatment, prevention of malaria.

Reference: Anonymous. n.d. 'Malaria and Right to Health'. Available online at <http://www.afmeurope.org/IMG/pdf/Paludisme-et-droit-a-la-sante.pdf> (Accessed in June 2011)

Section 8. Water, Poverty and Health Linkages

Poverty and health are indirectly proportional to each other, as ill-health can cause spiralling of poverty. This is mainly due to the high costs of health care in developing countries. Poverty and poor living conditions can also cause high morbidity and eventual mortality. Acute poverty increases risks associated with environmental health. In several developing countries, living below a certain economic level, also means limited access to clean water and decent levels of sanitation. This has a very negative impact on the public health of a geographical area, as inadequate access to water and sanitation causes a myriad of waterborne associated such as malaria, diarrhoea, cholera etc.

Policy makers and governments approach the problems of poverty, public health and water and sanitation separately. It would help to tackle all the problems simultaneously and more effectively, if the three problems are viewed together, and not in isolation.

8.1 Health and Poverty Linkages: Perspectives of the Chronically Poor

Poverty and health, or rather ill-health is intrinsically connected. The relationship is multi-faceted, as ill-health can be a catalyst for spiralling of poverty, as costs for organised health care are sky high, poverty and associated living conditions can also create and perpetuate diseases. Conversely, the relationship can also be positive. Poverty and ill-health can both have wide spread repercussions and effects that may impact a wider community. A sudden case of sickness in a family can cause a downward spiral of welfare losses, with the risk of an economic breakdown. An experience of poverty often includes ill-health, in poor countries. The paper also calls for policy inclusion keeping in mind, that ill-health should be treated in the sphere of socio-economic and political response to poverty reduction. The paper further identifies causes descent into poverty, identifying points of possible intervention.

Reference: Grant, Ursula. 2005. 'Health and Poverty Linkages: Perspectives of the Chronically Poor', Background Paper for the Chronic Poverty Report. Chronic Poverty Research Centre. Available online at <http://www.odi.org.uk/resources/download/2066.pdf> (accessed in June 2011)

8.2 Poverty, Health and Environment: Placing Environmental Health on Countries' Developmental Agendas.

The report emphasises on the importance of environmental health in the reduction of poverty and in ensuring sustainable development, however, they rank very low in policy makers' developmental agenda. In this sphere, there are significant chances to affect change in a setting like the urban slum, where there is an overlap of poverty, health and environmental issues. Working across disciplines is a huge challenge, and a holistic approach to tackle poverty, environment and health is elusive.

Reference: Poverty-Environment Partnership. 2008. 'Poverty, Health and Environment: Placing Environmental Health on Countries' Developmental Agendas', Joint Agency Paper. Poverty-Environment Partnership. Available online at siteresources.worldbank.org/EXTENVHEA/Resources/PovHealthEnvCRA.pdf (accessed in June 2011)

8.3 Poverty and Water Supply and Sanitation Services

This paper, presented in a regional workshop of financing community water supply and sanitation, discusses the phenomenon of water with respect to water and sanitation. It is woven around the proposition that solutions for inadequate sanitation and water supply lies outside the water sector, and that the key to eradication of poverty. The paper primarily calls for a paradigm shift in tackling the twin issues of poverty and water supply and sanitation. It is a

call to recognise that a problem like poverty eclipses other issues. It asks governments and citizens to shift from a single sector, services provision to appreciate broader realities of an economic, political and social system.

Reference: Abrams, Len. 1999. 'Poverty and Water Supply and Sanitation Services', Paper Prepared for the Regional Workshop on Financing Community Water Supply and Sanitation held at While River, South Africa, 29 November 1999. Available online at http://www.africanwater.org/Documents/Poverty_and_sustainability.PDF (accessed in June 2011).

8.4 Water for Food, Agricultural and Rural Livelihoods

With rising population, demand for water needs improved attention in the sphere of environmental issues. However, this is ignored by agricultural policies, where water for food remains a core issue. To achieve optimal results in irrigated agriculture, negotiation needs to take place with other users, keeping in mind growing scarcity. Farmers need to be trained in contemporary conservation methods, given that they are at the centre of probable change. They also need to be given appropriate incentives, so that their agricultural practices will not have a detrimental effect on the biodiversity. The other challenge is providing rural people support to live a healthy, safe and productive life, and support their economic, social and environmental aspirations.

Reference: FAO (Food and Agriculture Organization of the United Nations) and IFAD (International Fund for Agricultural Development). 2006. 'Water for Food, Agriculture and Rural Livelihoods', in World Water Assessment Programme (WWAP), 'Water: A Shared Responsibility', the United Nations World Water Development, Report 2. Paris: United Nations Educational, Scientific and Cultural Organization and New York: Berghahn Books. Available online at <ftp://ftp.fao.org/docrep/fao/010/i0132e/i0132e02.pdf> (accessed in June 2011)

8.5 Securing Food for a Growing World Population

Food and agriculture sectors are major consumers of water resources, these sectors require almost 70% of water that is used for irrigation. Despite food production increasing to keep pace with the global population in recent decades, hundreds of millions of people in the world continue to remain undernourished. This food insecurity is further fuelled by rapid urbanization in developing countries. This chapter explains the status of global food production in entirety, studying how its production can be increased while ensuring environmental sustainability, and accounting for allied sectors such as fisheries. It examines the effect of neo-liberal policies in food security, and attempts to bring out the connection between food security and poverty rates.

Reference: FAO (Food and Agriculture Organization), WHO (World Health Organization), UNEP (United Nations Environment Programme) and IAEA (International Atomic Energy Agency). 2006. 'Securing Food for a Growing World Population', in 'Water for People: The 1st UN World Water Development Report'. pp. 189-223. Paris: United Nations Educational, Scientific and Cultural Organization and New York: Berghahn Books. Available online at <http://www.unesco.org/water/wwap/wwdr/pdf/chap8.pdf> (accessed in June 2011)

8.6 Water, Health and Poverty Linkages: A Case Study from Sri Lanka

There is a close relationship among water, health and poverty. Health and poverty are interdependent, in the sense that while good health brings prosperity and vice versa. The converse is true as well, with poor health creating and perpetuating poverty. Water, however, is at the heart of this equation, contributing to both health and poverty. While water impacts health directly in terms of drinking water and sanitation, it is a key factor in agricultural processes, and therefore in the lives of poor people. Poverty causes detrimental degradation of natural resources, influencing environmental health, thereby creating acute conditions of poverty. This paper explores these linkages, using a case study from Sri Lanka for context.

Reference: Abayawardana, Sarath and Intizar Hussain. 2002. 'Water, Health and Poverty Linkages: A Case Study from Sri Lanka', Paper prepared for the 'Asian Development Bank Regional Consultation Workshop on Water and Poverty' held in Dhaka during between 22-26 September 2002. Available online at http://www.adb.org/water/actions/sri/SRI_water_health_poverty.pdf (accessed in June 2011).

8.7 Assessing the Health of the Poor: Towards a Pro-Poor Measuring Strategy

Being able to measure the health of low income people is becoming very vital, as health has been identified as having an important connection with poverty. Added to this, health and equitable distribution of wealth are important developmental goals in themselves. The present poverty reduction programmes need an affective monitoring and evaluation process that is accepted nationally.

While reviewing and throwing light on the range of tools for collecting data on health and socio-economic status, the paper argues that many of these methods are not effective in analysing and assessing the health of the poor. A strategy for building on existing data sources, was outlined, and supplementary studies in addition to techniques like poverty mapping has also been suggested.

Reference: Diamond, Ian, Zoë Matthews and Rob Stephenson. 2001. 'Assessing the Health of the Poor: Towards a Pro Poor Measurement Strategy', Issue Paper. London: Department for International Development Health Systems Resource Centre. Available online at <http://www.dfid.gov.uk/r4d/PDF/Outputs/HOppsIssuesPaperDiamond.pdf> (accessed in June 2011)

8.8 Social Cost-Benefit Analysis of Improved Water Quality in Rural Areas: An Exploratory Study in Coastal AP

This study assesses the social and economic benefits of a proposed water purification project in coastal rural Andhra Pradesh. In doing so, it touches upon the benefits that the project will have on public health, the economic benefits of good public health, the number of man days earned thanks to good health. Qualitative and quantitative methods were used in the study that spanned six villages in three districts. The analysis was carried out from a social development point of view, rather than purely an economic perspective. The study concludes that there are confirmed health benefits and that there is a substantial economic loss due to ill health.

Reference: Reddy, V Ratna, M Kullappa and D Mohan Rao. 2008. 'Social Cost-Benefit Analysis of Improved Water Quality in Rural Areas: An Exploratory Study in Coastal AP', *Journal of Social and Economic Development*, Vol. 10, No. 1. pp. 68-97. Available online at [http://www.isec.ac.in/JSED%20Vol.%2010%20No.%201%20\(Jan.%20-%20June%202008\).pdf](http://www.isec.ac.in/JSED%20Vol.%2010%20No.%201%20(Jan.%20-%20June%202008).pdf) (accessed in June 2011).

Section 9. Water, Health and Gender

The state of water and sanitation has a huge bearing on women and their health. Thanks to the division of labour, the onus of collecting water for domestic use falls upon women and this means that they suffer from spinal injuries and pelvic deformities as a result of carrying water on their heads. They are also more vulnerable to malaria and diarrhoea that arises because of inconsistencies in water quality. Studies have shown that much of this disease burden (almost one-tenth) can be prevented by enhancing water infrastructure, and improving the overall management of water resources.

Women also have specialist sanitation needs for menstruation, child bearing and birth, etc. Maternal and infant morbidity and mortality can be improved by providing adequate infrastructural support. Schools, temples and other public spaces must have separate toilets for women. There have been innumerable cases of girls and women missing school and work, because they are menstruating, and the loss of working days causes substantial economic and social losses, not just to the concerned households, but also to the national and global economies. Thought can also be put into the design and location of latrines, close to homes, as this can be instrumental in reducing violence against women, which tends to occur as women relieve themselves in the open after nightfall.

As far as nutrition and post-natal health is concerned, water plays a crucial role. Therefore, water has many gender dimensions, and the governance and management of water resources should be inclusive of female participation.

9.1 Child Malnutrition and Gender Discrimination in South Asia

Bangladesh, India and Pakistan have 50% of the world's malnourished children. Despite being nuclear states, India and Pakistan, account for more undernourished children than any other countries. Even malnutrition rates in sub-Saharan Africa are lower than the malnutrition rates in India. In the first section, the paper presents a conceptual framework on the phenomenon of child malnutrition, it then presents the nutritional status of children in a cross-regional perspective, concluding that the worst malnutrition rates in the world are found in South Asia. The paper also discusses some policy implications.

Reference: Mehrotra, Santosh. 2006. 'Child Malnutrition and Gender Discrimination in South Asia'. *Economic and Political Weekly*, Vol. 41, No. 10, pp. 912-918. Available online at http://www.jsk.gov.in/articles/gender_discrimination_in_south_asia_santosh_mehrotra.pdf (accessed in July 2011).

9.2 Arsenic Exposure During Pregnancy and Size at Birth: A Prospective Cohort Study in Bangladesh

The paper evaluates the associated between individual arsenic exposure of pregnant women in Bangladesh, and the corresponding birth weight of the child. The study was conducted in the Matlab area and included a sample size of 1,697 women. It was found that 93% of mother-infant pairs showed arsenic concentration in their urine, and this adversely affected the health of the newborn, with 32% found to be having below average birth weight.

Reference: Rahman, Anisur, Marie Vahter, Allan H. Smith, Barbro Nermell, Mohammed Yunus, Shams El Arifeen, Lars-Ake Persson, and Eva-Charlotte Ekstrom. 2009. 'Arsenic Exposure During Pregnancy and Size at Birth: A Prospective Cohort Study in Bangladesh', *American Journal of Epidemiology*, Vol. 169, No. 3, pp. 304-312. Available online at <http://aje.oxfordjournals.org/content/169/3/304.full.pdf+html> (accessed in August 2011).

9.3 Pregnancy Outcomes, Infant Mortality, and Arsenic in Drinking Water in West Bengal, India

The paper is an outcome of a two year study on pregnancy outcomes and infant mortality among 202 married women in the eastern state of West Bengal in India. Structured interviews were conducted among women to ascertain their reproductive histories. Measurements from 409 wells were used to detect arsenic exposure. There was found to be a manifold increase of risk of stillbirth with high exposure to arsenic during pregnancy. While no association was found between arsenic exposure and spontaneous abortion, the study showed definitive evidence of link between high levels of arsenic and stillbirth.

Reference: Ehrenstein, O. S. von, D. N. Guha Mazumder, M. Hira-Smith, N. Ghosh. Y. Yuan, G. Windham, A. Ghosh, R. Haque, S. Lahiri, D. Kalman, S. Das and A. H. Smith. 2006. 'Pregnancy Outcomes, Infant Mortality, and Arsenic in Drinking Water in West Bengal, India', *American Journal of Epidemiology*, Vol. 163, No. 7, pp. 662-669. Available online at <http://aje.oxfordjournals.org/content/163/7/662.full.pdf+html> (accessed in August 2011).

9.4 Gender Millennium Development Goal: What Water, Sanitation and Hygiene Can Do in India

This is a note which uses the Millennium Development Goals as a backdrop to describe how proper facilities in water and sanitation can improve gender equality in India. It rationalises on why water, sanitation and hygiene are particularly important for women and their health conditions. Facts and listed and a rationale note is provided under each of these subheadings: Gender & Domestic Work, Gender & Income Generation, Gender & Education, Gender & Health and Gender & Social Mobility.

Reference: John, Isaac. 2005. 'The Gender Millennium Development Goal: What Water, Sanitation and Hygiene Can Do in India', Well Country Note 4.1. Available online at <http://www.lboro.ac.uk/well/resources/Publications/Briefing%20Notes/WELL%20CN%204.1%20-%20Gender.pdf> (Accessed in September 2011).